Cell Phones as Data Probes: Background & Recent US Wireless Experience

North America Traffic Monitoring Exhibition & Conference

US WIRELESS

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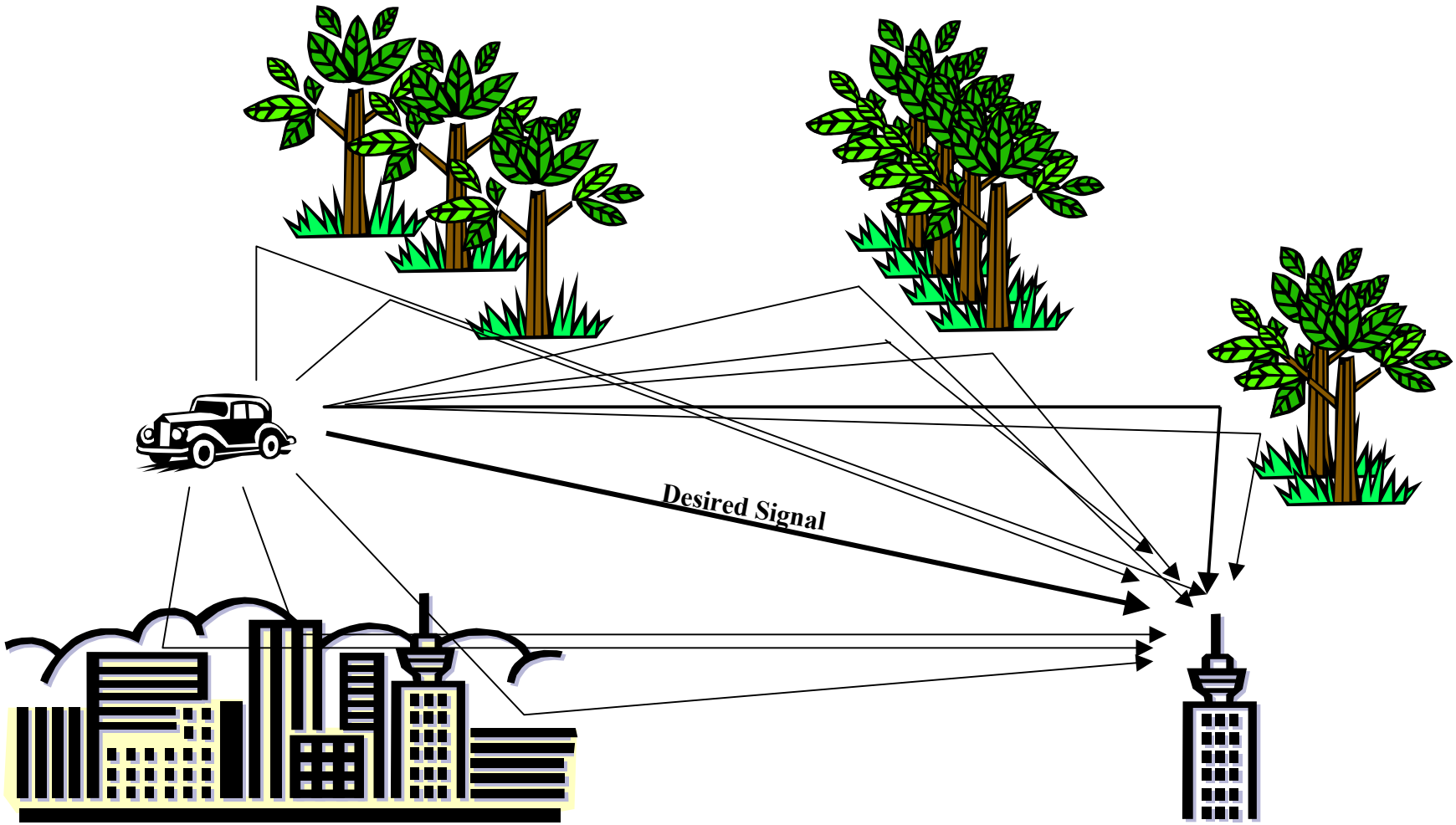
Why the New-Found Interest in Location Data?

- **Regulatory: Federal Communication Commission Rule**
  - **Mandates wireless carriers to locate E911 calls by October 2001**
  - **Sets standards (within 100 meters 67% of time)**
  - **Choice of technology: network or handset based**
- **Transportation/ ITS**
  - **Congestion growing and traditional solutions have not met demand**
  - **Lack of meaningful data on system performance --travel times and speeds -- limits ability to manage system and does not provide individuals with information they need to make intelligent choices**
  - **Traffic data limited:**
    - **Some expressways; but very few arterials**
    - **Traffic sensors are unreliable and expensive**
    - **Not integrated across modes**
    - **Need to personalize: fit individual needs**
- **Location Commerce**
  - **Interaction between Internet and wireless phones**
  - **Add spatial interaction to economy**

Electromagnetic noise degrades the accuracy of all position location techniques

- **There are two predominant forms of electromagnetic noise:**
  - **Additive Gaussian Noise**
  - **Multiplicative Multipath Noise**
- **Additive Gaussian noise is present in all forms of communications. The typical approach to mitigation simply provides the desired transmission with sufficient power to overcome it.**
- **Multipath noise cannot be mitigated as such, since it derives from the energy of the original transmission; thus, increasing the transmitted power merely increases the undesired multipath.**

Multipath noise derives when the transmitted electromagnetic wave reflects from myriad obstacles between the source (transmitter) and sink (receiver)



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Pattern recognition based techniques solve the electromagnetic noise problem by matching its characteristics rather than trying to mitigate its effects

- **These techniques "map" the actual multipath signatures and then match subscriber transmissions to the known patterns.**
- **This approach identifies locations based on their unique multi-path signature.**
- **In sum, pattern recognition makes multipath work on behalf of the system rather than leaving it to remain an interference.**

The RadioCamera™ employed by US Wireless Corporation is the only commercial pattern recognition technique

How the US Wireless System Works

Advantages of a Network Solution

- Passive: uses cell phones as anonymous data probes
- Scalable: can cover every road and bus or rail route
- Granular: can adjust data collection to fit individual needs
- Digital: eases links with internet and wireless networks
- Supports multiple markets
- An order of magnitude less expensive to install than alternatives (see chart)
- Real-time
- Provides unique data archive for planning
- Adaptable to future changes

What Information it Provides

- Speed – by link
- Direction
- Acceleration – are things getting better or worse?
- Location – using existing cell phones or beacons
- Covers all roads – expressways and arterials and beyond
- Covers all locations
  - Downtown
  - Inside Buildings (within limits)
  - Off Road
- Use low cost beacons to track vehicles and mobile assets
  - Buses, containers, repair trucks

The system generates direct measures of service quality for the traveling public, such as average speeds and link travel times

- **Our building block approach allows for specification of links for**
  - **Block-by-block**
  - **Interchange-by-interchange**
  - **Milepost based**
  - **Combinations of the above**
- **It covers all relevant roadways**
  - **Interstates, and other expressways**
  - **Major arterials, as well as those with longer time periods**
  - **Special event sites (i.e., Stadia, convention centers)**
- **It can match a variety of time periods**
  - **Minute-by-minute aggregations**
  - **Specified peak busy hours**
  - **Any sort of averaging segment chosen**
- **As well as integration of data from other existing systems, such as road sensors, beacons, or GPS**

Our network approach allows full coverage, real-time reporting, and consistency

- **The RadioCamera™ Network obtains full geographic coverage of all roads**
  - **Including those not covered by sensors**
  - **Urban, rural and suburban**
- **It allows for focus on sub-regions, such as**
  - **Corridors**
  - **City Centers**
  - **Airports, sea ports, shopping centers, et al**
- **It provides for real time reporting – measured in seconds**
- **It is consistent across all regions and roads**

The system could provide a wide variety of digital data supporting reporting formats

- **The reporting formats could range over**
  - **Maps**
  - **Specific indices, such as "traffic temperatures"**
  - **Made fully integrated with other systems**
- **The reporting formats could include other analytics, such as**
  - **Traffic volume estimates**
  - **Trip types**
  - **Statistics on commuter trips completed on time**
  - **O and D surveys**
  - **Predictive modeling**
    - **Patterns based on archival data**
    - **Statistics for day, season, weather conditions, etc.**

Technology Cost Comparison

TECHNOLOGY	Total Capital	Annual O & M
Video Image Processor	$8,370,000	$135,000
Inductive Loop Detectors	$3,825,000	$216,000
Microwave Doppler Radar	$3,345,000	$108,000
Active Infrared	$8,262,000	$41,000
RadioCamera	$1,400,000	$216,000

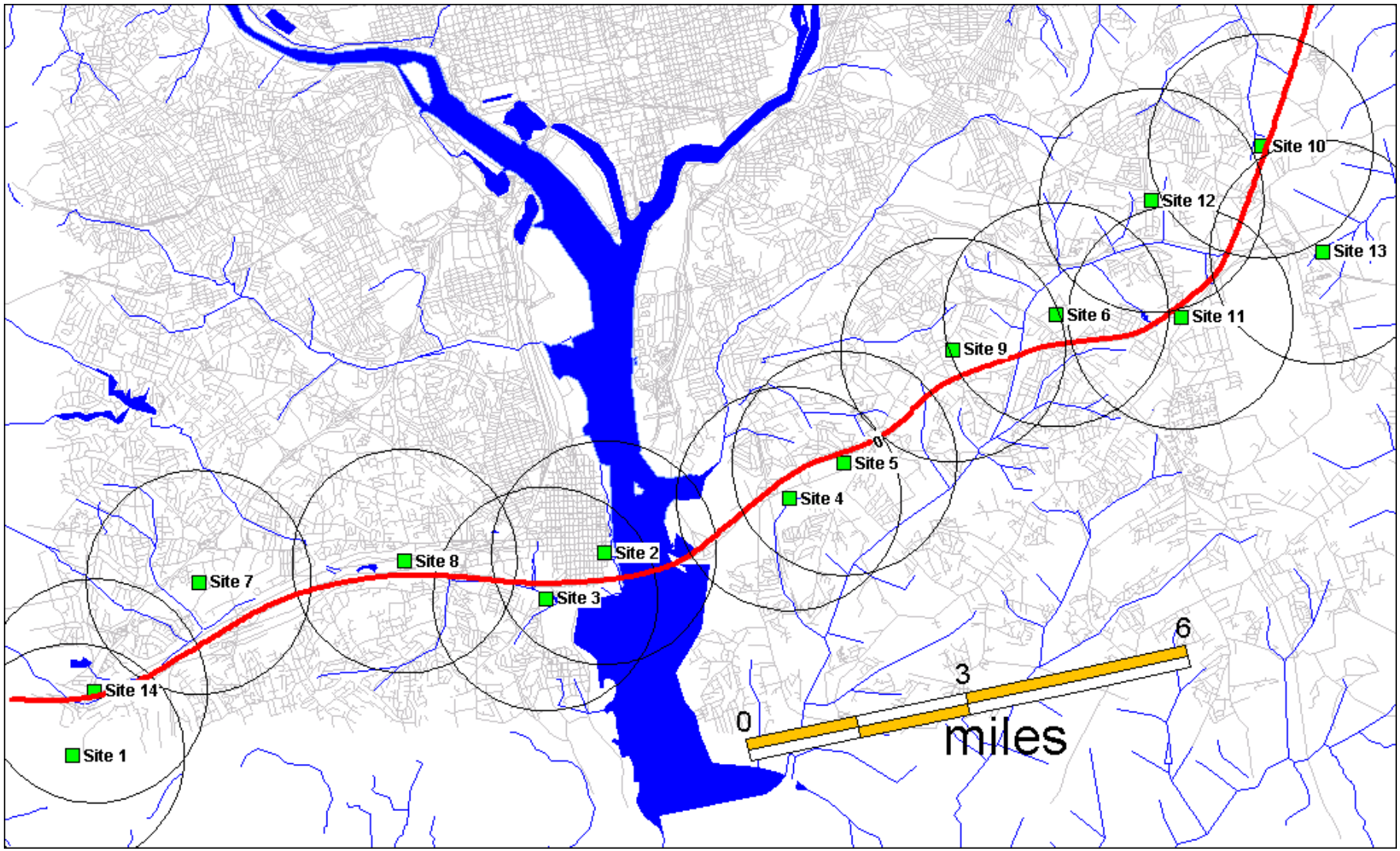
- **Study area covers 30 miles from Miami to Fort Lauderdale, including:**
  - **I-95**
  - **Florida Turnpike**
  - **210 miles of arterial roadways**
- **Assumes sensors are placed once per mile. Greater density increases costs for everything except RadioCamera.**

Source: PBS&J and US Wireless

Possible Uses

- **For Individuals**
  - **Speeds for all roads**
  - **Meaningful traffic data**
  - **Travel time forecasts**
    - **For alternate routes**
    - **For all modes**
- **For Public Agencies**
  - **Speeds and travel times by link**
  - **Performance measures**
  - **Cost effective vehicle location and Asset Management**
  - **Improved traffic flow**
- **For Business**
  - **Cost-effective vehicle location and Asset Management**
  - **Link with supply chain management**

Site Planning Diagram for Beltway Project (MD-VA)



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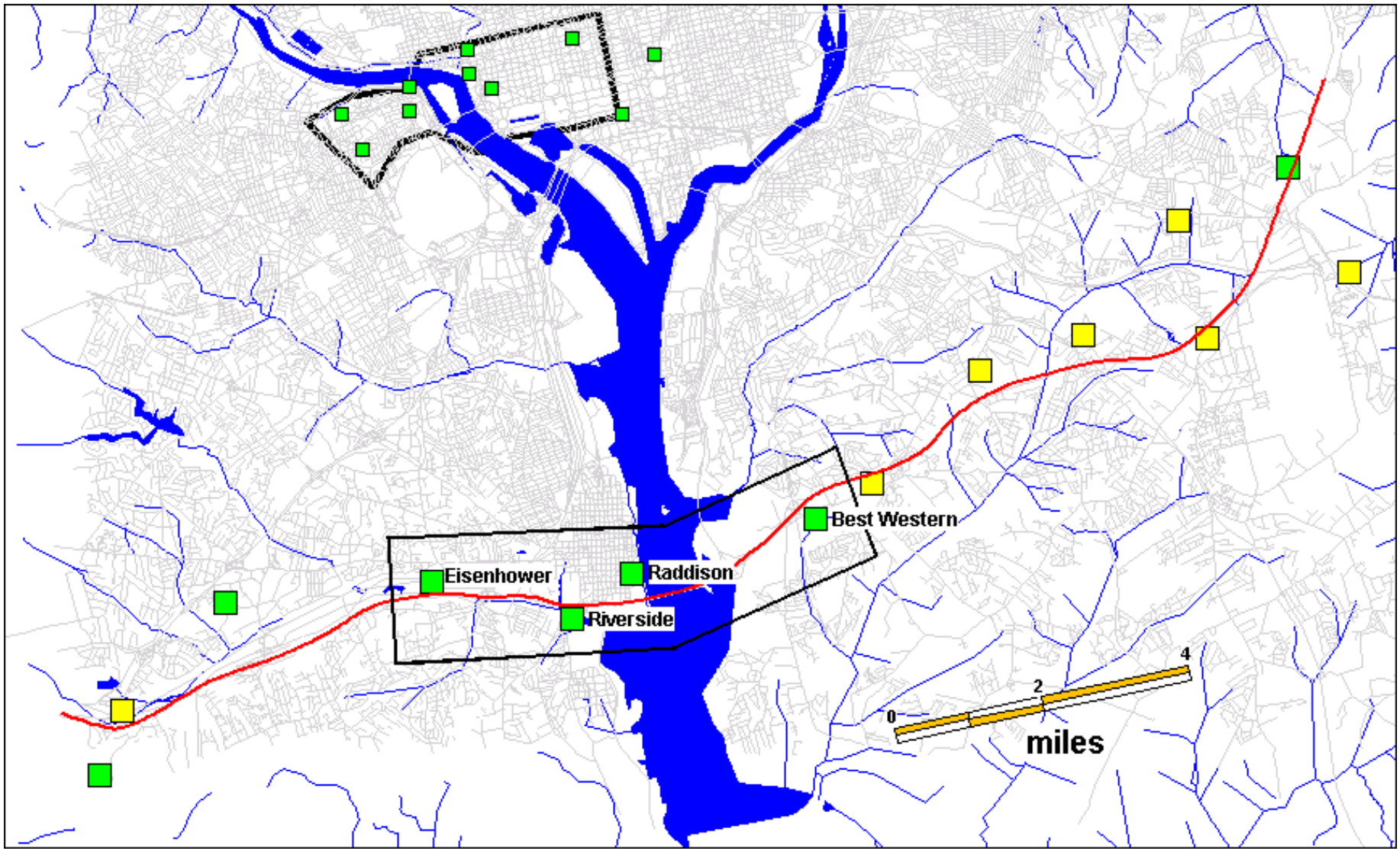
Site Diagram for Beltway Project – VA/MD



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Deployment Planned and Under Way

- **Washington, DC**
- **Baltimore, MD**
- **Hampton Roads, VA**
- **Oakland, CA**
- **Seattle, WA**
- **Billings, MT**
- **San Diego, CA**
- **San Francisco and San Jose, CA**
- **New Hampshire - Vermont - Maine**

Next Steps

- **What Types of Location/Traffic Data are Needed?**
  - **Speeds, Travel Times; AVL; Mayday**
  - **Density of Detail**
  - **Geographic Coverage**
- **Select Locations for RadioCameras**
  - **Select General Locations**
  - **Identify Specific Sites**
  - **Negotiate Leases**
- **Installation**
  - **Install RadioCameras**
  - **Deploy Communications Link to Regional Hub**
  - **Calibrate Network**
  - **Test Software**
- **Finance**
  - **Pay me now – cash or loan**
  - **Pay me later**

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